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The Effect of Respondent Experience/Knowledge in the Elicitation of Contingent Values: An Investigation of Convergent Validity, Procedural Invariance and Reliability

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Abstract. Tests of convergent validity and procedural invariance were used to investigate whether individuals lacking direct experience with a commodity can provide valid responses to contingent-valuation questions eliciting *ex post* use values. Convergent validity between samples with and without experience was shown to hold for dichotomous-choice responses, but not for open-ended responses.

Key words: contingent valuation, dichotomous choice, experience, open-ended, validity, use values

1. Introduction

Information requirements in contingent-valuation scenarios are influenced by the knowledge respondents bring to the valuation exercise. The experience can take the form of direct interaction with the resource or indirect experience through publicly available information. Very little research has been dedicated to investigating the effects of differing levels of respondent experience (Boyle et al. 1993; Roach et al. 1999 are among the few).

Boyle et al. (1993) investigated whether white-water boaters who had experienced a single flow level on the Colorado River could provide valid estimates of value for flows they had not experienced on that river. A test of convergent validity indicated that experience with one flow allowed respondents to provide valid estimates of value for flows not experienced, but the results were stronger for individuals with rafting experience on other rivers vis-a-vis individuals who had not rafted other rivers. Direct experience with the level of the commodity being provided was not necessary but related

experience with a similar resource was helpful. The related experience ostensibly provided respondents with experience with more than one flow as flow levels vary from river to river.

Roach et al. (1999) found that the conclusion for Colorado River rafting *was not robust* for an application to white-water boating on the Dead River in Maine. This conflicting finding highlights the fact that results from most empirical studies arise from a single application and may not extend to other applications.

While most of the controversy over contingent valuation stems from applications to nonuse values where some have argued that people have insufficient experiential knowledge, commonly manifested as choice experience, to provide valid responses to stated-preference questions, the findings described above indicate that the concern may also extend to estimation of use values. Moreover, *ex ante* evaluations are often required in the estimation of use values and direct experience may not hold because the specific resource condition being valued has not been realized.[1] For example, in cases of long-term contamination no one in the current population may have experienced conditions that would result if remediation occurred. In these instances, benefit transfers, often assimilated statistically via some form of meta analysis, have been used to infer value estimates. Common applications include Regulatory Impact Analyses by the US Environmental Protection Agency, RPA (Resource Planning Act) values used by the US Forest Service to formulate long-range plans, and in natural resource damage assessment (NRDA) legal cases to assess damages. These analyses often use an agglomeration of *ex post* and *ex ante* value estimates to predict what use values will be when a new resource condition is realized. Yet, nowhere in the literature can we find an assessment of how well an *ex ante* estimate of a use value for a resource condition people have not experienced predicts what the realized use value will be.

The question posed in this paper is whether individuals lacking direct experience with a ''commodity'' can provide valid responses to contingent-valuation questions eliciting *ex post* use values. The experiment is accomplished through a test of convergent validity (Carmines and Zeller 1979) using samples of individuals who have and have not hunted moose in Maine. Convergent-validity tests are accomplished using data from dichotomous-choice questions and from open-ended questions. Procedural invariance (Kahneman and Tversky 1984) is investigated by asking whether convergent-validity results are invariant to the contingent-valuation question (procedure) employed. Two years of survey data were collected, which further allows an investigation of whether the convergent-validity result is temporally reliable for the dichotomous-choice data.

2. Value Definitions

Each fall a fixed number of permits are issued by lottery for a 6-day moose hunt in Maine. All individuals who received permits to hunt were surveyed after completing their hunts and were asked an *ex post* use-value question (''Experienced'' sample). A sample was also selected of individuals who applied for a permit and were not selected in the lottery (''No-Experience'' sample).[2] Individuals in this latter sample were asked the same use-value question, but in an *ex ante* setting. These independent samples constitute the ''experience test'' component of the experimental design.

The value to be estimated for individuals in the Experienced sample is an *ex post*. compensating-variation measure of Hicksian surplus:

$$V(E, H = 1, Y - \theta) = V(E^C, H = 1, Y) \tag{1}$$

where $V(\bullet)$ is an indirect utility function, E is the price of a day of moose hunting, C denotes a choke price, H is an indicator variable that equals one if a person receives a moose-hunting permit, Y is income, and θ is the value to be estimated. All other terms are assumed constant and are suppressed for expositional convenience.

The value most relevant to individuals in the No-Experience sample is an *ex ante* option price (Bishop 1982):

$$V(E, H = 1, Y - \mathrm{OP}) = \pi V(E, H = 1, Y) + (1 - \pi)V(E, H = 0, Y) \tag{2}$$

where OP is a state-independent measure of option price, π is the probability of being selected in the lottery, and all other terms are defined above. Despite option price being the logical welfare measure for individuals who did not receive a permit, *we asked them to answer the question eliciting* θ, *as defined in* (1). We are asking whether people who *have not experienced* an environmental condition can provide value estimates that are statistically comparable to those provided by people who *have experienced* the condition.

3. Experimental Design

The study was conducted using data from the 1989 and 1990 moose hunts. All Maine residents selected to participate in the 1989 hunt were surveyed (Experienced sample, $n = 900$) along with a random sample of residents who applied for a permit in 1989 and *were not* selected in the lottery (No-Experience sample, $n = 600$). Individuals in the No-Experience sample were selected using the same lottery procedure used to allocate permits, and were told to assume they had been selected in the lottery and participated in the hunt when answering the valuation question.

The samples were randomly stratified into subsamples that answered either the same dichotomous-choice question (Experienced, $n = 700$, and No-Experience, $n = 500$) or the same open-ended question (Experienced,

$n = 200$, and No-Experience, $n = 100$). The text of these questions is replicated in Appendix A. Comparing the statistical results for the Experienced and No-Experience samples, for both question formats, comprise two tests of convergent validity.

While there have been numerous comparisons of welfare estimates from dichotomous-choice and open-ended questions (see Huang and Smith 1998), there are reasons to compare these question formats in other dimensions. It has been argued that dichotomous-choice questions are incentive compatible and that this is not the case for open-ended questions (Carson et al. 2000). On the other hand, it has been shown that respondents anchor on the bid amounts in traditional single-bounded, dichotomous-choice questions, which biases welfare estimates (Boyle et al. 1997). Here, rather than making another direct comparison of welfare estimates from dichotomous-choice and open-ended questions, we are asking whether the two question formats result in the same validity conclusion regarding respondents' experience, which is a novel test of procedural invariance. The comparison asks if these statistical comparisons result in the same conclusion whether the underlying tests are based on dichotomous-choice or open-ended data.

Prior reliability research has asked whether contingent-valuation questions provide statistically comparable value estimates at two distinct points in time (Carson et al. 1997; Teisl et al. 1995). Recognizing that each experiment here is essentially a single case study, we repeated the convergent-validity test with the dichotomous-choice question in 1990 to see if the result from the convergent-validity test was temporally reliable.

Only the dichotomous-choice question was used in 1990. Experienced ($n = 900$) and No-Experience ($n = 900$) samples of Maine residents were surveyed, and Experienced ($n = 100$) and No-Experience ($n = 100$) samples of nonresidents were surveyed; only 100 permits are issued to nonresidents each year. The resident results, when compared to the dichotomous-choice results for the 1989 data investigates whether the convergent validity finding is temporally reliable.

The comparison using residents and nonresidents in 1990 provides another test of procedural invariance in terms of sampling effects. It is reasonable to expect that residents are more likely than nonresidents to know someone who has participated in the hunt in preceding years and have access to information about the hunt that is publicly available.[3] We expect, therefore, that convergent validity is more likely to be established for the resident samples than for the nonresident samples.

The statistical hypotheses of convergent validity are shown in Table I. In all the tests using dichotomous-choice questions, we test the equality of distributions using vectors of estimated parameters rather than simply testing mean values. All parameter vectors (β) are composed of a constant term and the coefficient on the bid variable.[4] In the test using the open-ended question

Table I. Hypotheses tested

Year of data	Hypotheses[a,b]
1989	H_0: $\beta_{dc,R,E} = \beta_{dc,R,NE}$ (a)
	H_0: $\mu_{oe,R,E} = \mu_{oe,R,NE}$ (b)
1990	H_0: $\beta_{dc,R,E} = \beta_{dc,R,NE}$ (c)
	H_0: $\beta_{dc,NR,E} = \beta_{dc,NR,NE}$ (d)

[a] The notation in the hypotheses is defined as: dc denotes dichotomous-choice question, oe denotes open-ended question, R denotes resident, NR denotes nonresident, E denotes Experienced subsample, and NE denotes No-Experience subsample.
[b] In all cases, H_A: not H_0.

format, we test the equality of mean values. Failure to reject hypotheses (a), (b), (c) or (d) each indicates that convergent validity holds with respect to differing levels of respondent experience. Procedural invariance holds if the null hypotheses of no difference cannot be rejected for hypothesis (a) (dichotomous-choice data) *and* hypothesis (b) (open-ended data) using the 1989 data. Temporal reliability of the convergent validity result for the dichotomous-choice data holds if the null hypotheses of no difference cannot be rejected for hypothesis (a) (1989 data) *and* hypothesis (c) (1990 data). Procedural invariance of differing levels of inexperience holds if the null hypotheses of no difference cannot be rejected for hypothesis (c) (residents) *and* hypothesis (d) (nonresidents) using the 1990 data.

4. Survey Procedures

The survey instrument was designed in 1988 and a draft was pretested in a focus group. After revisions, the survey was pretested by mail ($n = 50$). The final draft of the survey was administered to all individuals who participated in the 1988 moose hunt. That survey, with slight modifications, was applied in 1989 and 1990.

The mail pretest of the 1988 survey was conducted using an open-ended question. Responses to that question were used to develop bid amounts for a dichotomous-choice question in the final 1988 survey instrument according to the protocol laid out by Boyle et al. (1988). Responses to the 1988 dichotomous-choice question were used to estimate a logistic cumulative distribution function that was used to assign bids to the 1989 and 1990 surveys using the same protocol used in 1988. The open-ended question used in 1989 was the same as that used in the 1988 pretest.

Surveys were administered immediately after the 1989 and 1990 hunts; people in the Experienced and No-Experience samples were surveyed concurrently. Response rates, along with initial sample sizes, for the eight subsamples are shown in Table II. All surveys had deliverable addresses.

Table II. Sample structure and response rates

		1989 Residents		1990 Residents		1990 Nonresidents	
		Experienced	No-Experience	Experienced	No-Experience	Experienced	No-Experience
Dichotomous-choice	Sample size	700	500	900	900	100	100
	Response rate	91%	79%	85%	85%	84%	69%
Open-Ended	Sample size	200	100	NA	NA	NA	NA
	Response rate	83%	77%	NA	NA	NA	NA

5. Results

5.1. CONVERGENT-VALIDITY TESTS AND PROCEDURAL INVARIANCE OF EXPERIENCE WITH THE 1989 DATA

Testing the estimated parameters (Table III) for the dichotomous-choice data results in the conclusion that null hypothesis (a) cannot be rejected at the 10% level ($\chi^2 = 3.9 < \chi^2(\text{df}=2) = 4.6$). Convergent validity holds for the dichotomous-choice question.

Table III. 1989 Logistic regression results (*t*-statistic in parentheses)

	Experienced	No-Experience
Constant (β_0)	1.0049 (6.22)	1.0650 (5.19)
Slope (β_1)	−0.0013 (−8.67)	−0.0016 (−7.44)
n	637	397
μ[a] (90% CI)[b]	$1,023 (922, 1,138)	$846 (748, 964)
$\chi^2(H_0: \beta_E = \beta_{NE})$	3.9	

[a] Means for the dichotomous-choice data are calculated by integrating the area below the inverse of the estimated logistic cumulative distribution function between $0 and the dollar amount where probability of acceptance equals 0.01. While some investigators have allowed for negative values, there is no reason to assume there are negative values in the current application; over 90% of the hunters got a moose and over 90% got a bull, the most desired sex. In addition, the questions were not framed in a manner to allow for expressions of negative values.

[b] Krinsky and Robb bootstrapping procedures were applied to calculate confidence intervals about the means (Park et al. 1991).

Results based on the open-ended question tell a different story. The Experienced sample mean is \$674 with a 90% confidence interval of (592, 756) and the mean for the No-Experience sample is \$469 with a 90% confidence interval of (410, 528). While the confidence intervals do not overlap, they are based on the assumption that the open-ended data are distributed normal. A Lilliefors test (Conover 1980) indicates the hypotheses that the open-ended response data are distributed normal can be rejected at the 5% level for both the Experienced and No-Experience subsamples. As a result, nonparametric tests were performed to investigate the difference in means. A Mann–Whitney test (the nonparametric analog to the *t*-test) indicates that hypothesis (b) can be rejected at the 5% level. A permutations-based procedure using Euclidean distance to the first power (Slauson et al. 1991) was also utilized because distance-based statistics have greater power, defined as the probability of rejecting the null hypothesis when it is false, to detect location shifts of central tendency between skewed distributions (Zimmerman et al. 1985; Biondini et al. 1988). The permutations procedure also indicates hypothesis (b) can be rejected for the open-ended data.

These results indicate that direct hunting experience is not needed for convergent validity to hold for dichotomous-choice questions, but this is not true for the open-ended questions. These conflicting statistical results indicate that procedural invariance does not hold; the dichotomous-choice and open-ended questions do not result in the same validity conclusion.

5.2. CONVERGENT-VALIDITY TESTS AND PROCEDURAL INVARIANCE OF EXPERIENCE WITH THE 1990 DATA

Tests that the vectors of estimated parameters (Table IV) are equal cannot be rejected for residents ($\chi^2 = 1.4 < \chi^2(\mathrm{df}=2) = 4.6$) or nonresidents ($\chi^2 = 2.2 < \chi^2(\mathrm{df} = 2) = 4.6$), hypotheses (c) and (d). Thus, convergent validity holds for both resident and nonresident samples. Even though nonresidents have less knowledge of the moose hunt than do residents, this statistical result suggests they have sufficient knowledge for convergent validity to hold. The dichotomous-choice estimation results reveal procedural invariance holds for differing levels of respondent inexperience.

5.3. TEMPORAL RELIABILITY OF DICHOTOMOUS-CHOICE CONVERGENT-VALIDITY TEST

Convergent validity holds for the resident, dichotomous-choice data in both 1989 and 1990. Thus, the finding of convergent validity is temporally reliable.

Table IV. 1990 Logistic regression results (*t*-statistic in parentheses)

	Resident		Nonresidents	
	Experienced	No-Experience	Experienced	No-Experience
Constant (β_0)	1.1111 (7.80)	0.8796 (6.17)	1.1460 (2.53)	2.2151 (3.29)
Slope (β_1)	−0.0012 (−9.82)	−0.0011 (−8.79)	−0.0009 (−2.98)	−0.0017 (−3.58)
n	769	763	84	69
μ[a] (90% CI)[b]	$1,136(1,050–1,269)	$1,137(1,045–1,291)	$1,623(1,283–2,600)	$1,391(1,170–1,778)
$\chi^2(H_0{:}\beta_E = \beta_{NE})$	1.4		2.2	

[a] Means for the dichotomous-choice data are calculated by integrating the area below the inverse of the estimated logistic cumulative distribution function between $0 and the dollar amount where probability of acceptance equals 0.01. While some investigators have allowed for negative values, there is no reason to assume there are negative values in the current application; over 90% of the hunters got a moose and over 90% got a bull, the most desired sex. In addition, the questions were not framed in a manner to allow for expressions of negative values.

[b]Krinsky and Robb bootstrapping procedures were applied to calculate confidence intervals about the means (Park et al. 1991).

6. Discussion

As was pointed out in the Introduction, most economists take as given that people who have experienced a commodity can more accurately assess its value than can people who have no experience with the commodity. We have shown that dichotomous-choice responses do exhibit convergent validity of estimated *ex post* Hicksian surplus between samples who do and do not have experience. This result holds for people who have differing levels of experience, procedural invariance, and it is temporally reliable. Convergent validity did not hold for open-ended response data, which indicates that procedural invariance does not hold for the finding of convergent validity between the dichotomous-choice and open-ended responses.

The failure to establish procedural invariance between dichotomous-choice and open-ended validity tests could arise from inherent limitations of either question format. For example, respondents' anchoring on bid levels and a greater degree of imprecision inherent in using dichotomous-choice question binary responses might influence convergent validity based on dichotomous-choice questions. However, the robustness of the validity results based on dichotomous-choice questions provides strong evidence that this is another dimension where this question format is superior to an open-ended question in the elicitation of Hicksian surplus.

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Notes

1. This is exactly the reason that some investigators have begun to explore pooling revealed-preference and stated-preference data (Haener et al. 2001); revealed-preference data do not exist for at least some of the resource conditions requiring value estimates.
2. The probability of being selected in the lottery for the moose hunt is less than 2% and once a person receives a permit they cannot reapply for 10 years. The hunt was established in 1984 so none of the people in our samples from the 1989 and 1990 hunts would have previously received a permit to hunt moose in Maine.
3. This supposition is confirmed by the fact that most nonresidents hire guides to lead their hunts, while this is not common for residents. Wildlife biologists who meet hunters at check stations also believe that nonresidents possess less knowledge than residents about moose hunting in Maine.
4. The specification in equation (1) suggests that the equations should include a term $(E-E^C)$. We do not have a measure of E^C, which means that including just the observed E in the equation would involve measurement error. Including just E in the equation would result in a biased parameter estimate that has the wrong sign. Omitting $(E-E^C)$ does not create a problem because bid amounts were randomly assigned, which means the bid amount and the omitted variable are not correlated. Thus, there is no omitted variable bias in the estimation of the marginal utility of money, the coefficient on the bid variable. The constant term includes the mean of $(E-E^C)$ multiplied by its utility coefficient.

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Appendix A. Text of valuation questions for the 1989 surveys

Dichotomous-choice question for Experienced sample[a]	Dichotomous-choice question for No-Experience sample
Hunting expenses often go up or down. For example, gas prices rose substantially in the 1970s, fell somewhat in the early 1980s, and have recently risen again. Would you still have gone moose hunting in Maine during 1989 if your total expenses had been $–more than the total you just calculated? (CIRCLE ONE NUMBER) 1 YES 2 NO	Hunting expenses often go up or down. For example, gas prices rose substantially in the 1970s, fell somewhat in the early 1980s, and have recently risen again. Would you have gone moose hunting in Maine during 1989, if you had received a permit for the 1989 moose hunt and your total expenses had been $–more than the total cost *you* just estimated? (CIRCLE ONE NUMBER) 1 YES 2 NO

Appendix A. Continued

Open-ended question for Experienced Sample	Open-ended question for No-Experience Sample
Hunting expenses often go up or down. For example, gas prices rose substantially in the 1970s, fell somewhat in the early 1980s, and have recently risen again. What is the most that your 1989 moose hunt could have cost before you would have decided that it was too expensive and you would not have hunted moose in Maine during 1989? (FILL IN THE BLANK) $–IS THE MOST THAT I WOULD HAVE PAID FOR MY 1989 MAINE MOOSE HUNT.	Hunting expenses often go up or down. For example, gas prices rose substantially in the 1970s, fell somewhat in the early 1980s, and have recently risen again. Considering *your* 1989 moose hunt, if you had received a permit for the 1989 moose hunt, what is the most that your 1989 moose hunt could have cost before you would have decided that it was too expensive and you would not have hunted moose in Maine during 1989? (FILL IN THE BLANK) $–IS THE MOST THAT I WOULD HAVE PAID FOR MY 1989 MAINE MOOSE HUNT.

[a] The 1990 dichotomous-choice questions for the Experienced and No-Experience samples for both residents and nonresidents were the same as the 1989 dichotomous-choice questions. Only the year was changed.